Appendix D. Guide to Mitigation Strategies[1]

Mitigation strategies or activities fall into six general categories. These categories are explained in the next section. The second and third sections provide more detail on common mitigation activities.

I. General Categories

Prevention

Preventative activities are intended to keep hazard problems from getting worse. They are particularly effective in reducing a community's future vulnerability, especially in areas where development has not occurred or capital improvements have not been substantial. Examples of preventative activities include:

- Open space preservation
- Storm water management
- Drainage system maintenance
- Shoreline/riverine setbacks
- Capital Improvement Plans/critical facility placement
- Special assessment districts

Local land use plans and ordinances can be used to limit development in hazard-prone areas or to prevent areas from becoming worse. Examples of local enforcement tools that can be used include:

- Planning and zoning
- Floodplain regulations

Property Protection

Property protection measures protect new or existing structures by modifying the building to withstand hazardous events, or removing structures from hazardous locations. Examples include:

[1] This document is based, in part, on the City of Chesapeake (VA) Hazard Mitigation Plan. Portions of this document also were drawn from the *Tools and Techniques: An Encyclopedia of Strategies to Mitigate the Impact of Natural Hazards* developed by the State of North Carolina in 2002, and the *Planning for Natural Hazards: Oregon Technical Resource Guide* developed by the Oregon Natural Hazards Workgroup, Community Service Center at the University of Oregon.

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection
- Building codes (enforcement)
- Safe rooms
- Basement backflow prevention
- Retrofitting (i.e., windproofing, floodproofing, seismic design standards, etc.)
- Wind shutters

Natural Resource Protection

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their mitigation functions. Such areas include floodplains, wetlands, and dunes. Parks, recreation, or conservation agencies and organizations often implement these measures. Examples include:

- Floodplain protection
- Riparian buffers
- Vegetative planting and treatment / slope stabilization / fire-resistant landscaping
- Fuel breaks
- Wetland preservation and restoration

Structural Projects

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the environmental natural progression of the hazard event. They are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Channel modification
- Levees / dikes / floodwalls
- Diversions / detention / retention
- Reservoirs
- Utility protection / upgrades
- Wind retrofitting / windproofing

Emergency Services

Although not typically considered a "mitigation technique," emergency service measures do minimize the impact of a hazard event on people and property. These

commonly are actions taken immediately prior to, during, or in response to a hazard event. Examples include:

- Warning systems
- Evacuation planning and management
- Sandbagging for flood protection

Public Information and Awareness

Public information and awareness activities are used to advise residents, business owners, potential property buyers, and visitors about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Speaker series/demonstration events
- Hazard map information
- Real estate disclosure
- Library materials
- School children education
- Hazard expositions
- Websites

II. General Multi-Hazard Mitigation Activities

The following potential mitigation activities can be used to address one or more hazards. These activities also can benefit a community's overall hazard reduction efforts. Activities that are specific to a particular hazard are explained in the third section.

The mitigation activities selected should be linked to the Planning District's goals and objectives, and must address each jurisdiction's hazard risks and vulnerability outlined in the plan's Hazard Identification and Risk Assessment.

Building Codes

Building codes regulate the design, construction, and maintenance of construction within most communities. These regulations prescribe standards and requirements for occupancy, maintenance, operation, construction, use, and appearance of buildings. Building codes are an effective way to ensure than new and extensive re-development projects are built to resist natural hazards. In Virginia, communities are required by law to adopt and enforce the Uniform Statewide Building Code, which has provisions

for wind, water, and seismicity. Changes to the code are made by petitioning the International Code Council.

The USBC provides optional enforcement regulations to protect occupants of existing buildings and structures from health and safety hazards arising from the improper maintenance and use of those buildings and structures. Enforcement of the building code for new and existing structures is key to realizing the full health and safety benefits of the code.

Capital Improvement Plans/Critical Facility Placement

Capital improvement plans typically provide for the future and ongoing provision of public facilities and infrastructure. These plans can be vital tools in keeping new development out of high-hazard areas by limiting the availability of public infrastructure. Public facilities can often be relocated to less hazardous areas in the aftermath of a disaster. Public utilities also can be relocated, or they can be upgraded or floodproofed. Power and telephone lines can be buried underground.

In order to maximize the gravity flow area of wastewater treatment plants, the facilities are often located at the lowest elevation in the community. If this point lies within a floodplain for example, consideration may be given to relocating or floodproofing such facilities. New locations for critical facilities should not be in hazard-prone areas, or in areas where their function may be impaired by a given hazard event (i.e., where water can flood the access roads). Critical facilities should be designed and/or retrofitted in order to remain functional and safe before, during, and after a hazard event.

Comprehensive Plans

Comprehensive plans address how and where a community should grow by guiding the rate, intensity, form, and quality of physical development. These plans address land use, economic development, transportation, recreation, environmental protection, the provision of infrastructure, and other municipal functions. Comprehensive plans help to guide other local measures such as capital improvement programs, zoning ordinances, subdivision ordinances and other community policies and programs. By including natural hazard considerations into the plan, mitigation become integrated with community functions and could therefore be an institutionalized part of a jurisdiction's planning efforts.

Density and development patterns should reflect the Planning District communities' ability to protect their jurisdictions, the environment, and the ability to evacuate the area. Development management tools should be incorporated into the local policies that address the location, density, and use of land, with a particular emphasis on development within high-risk areas. Efforts should be made to keep people and property out of high-hazard areas whenever possible. Particularly hazardous areas could be used for recreational uses, open space, or wildlife refuges.

Critical Facilities Protection

Critical facilities, such as hospitals, fire and police stations, and sewage treatment plants are crucial for day-to-day survival of a community. Ensuring that these facilities have been built to withstand the impacts of natural disasters is crucial. This includes placement of the buildings in areas that are not hazard-prone and incorporating mitigation measures such as floodproofing, wind shutters, and hurricane straps into the construction of the building.

Evacuation Planning and Management

An orderly and safe evacuation requires planning and a pre-determined management strategy. This includes pre-identifying emergency evacuation routes and communicating that information to the public. In addition, people needing assistance, such as the elderly or those with special needs, should be identified and plans made to assist them if an evacuation were to occur.

Another component of evacuation planning is ensuring that shelter facilities will be available. Potential shelter locations must be identified and publicized and efforts must be made to ensure that the proper supplies and staff are available if the shelter is activated.

Neighborhood Access

Provide additional means of access into single-entry neighborhoods, in order to prevent residents from becoming trapped in a hazardous area during a wildfire or flood.

Public Outreach and Education Programs

Educating the public about what actions they can take to protect themselves and their property from the effects of natural hazards can be an effective means for reducing

losses. These types of programs could target public officials, citizens, businesses, or the local construction trade. The program could cover preparedness, recovery, mitigation, and general hazard awareness information. Potential outreach and education topics include:

- Flood insurance
- Hazard mitigation for homeowners (including manufactured homes and trailers), renters, and businesses
- Emergency preparedness for families, businesses, and special needs populations
- Driver safety in disasters
- Sheltering and evacuation

Ways of delivering this information include:

- Speaker series / demonstration events
- Hazard expositions
- Hazard curriculums for schools
- Hazard map dissemination
- Real estate disclosure
- Library materials
- Websites

Special Assessment Districts

Special assessment districts apply to property owners who directly benefit from a specific public improvement. These owners of both new and existing development in the district are charged a fee that is proportional to the benefits received from the improvement. There are a number of ways to apply this technique, from temporary assessments that raise revenue for a specific improvement to indefinite assessments that fund independent, special purpose governmental entities. The former could be used to fund structural projects, such as a floodwall, while the latter could be used to establish a regional floodplain management organization.

Another example might be the creation of a "special storm services" district, where funds would go toward mitigation, recovery and response activities. In other cases, the fee could be used to pay for the upkeep of stormwater management system or as a way of providing for the future replacement of roads and utilities at the public expense. These charges may or may not have the effect of discouraging development in the assessment district. However, they do transfer some of the cost of living or doing business in a hazard-prone area to those who choose to do so.

Utility Protection/Upgrading

Buried power lines can offer uninterrupted power during and after severe storms (both wind and winter storms). Burying power lines can significantly enhance a community's ability to recover in the aftermath of a disaster. Buried power lines are typically more expensive to maintain and are more vulnerable to flooding. Encouraging back-up power resources in areas where burial is not feasible will enable the continuity of basic operations (e.g., security, refrigeration, and heat) for businesses and facilities when there is a loss of power.

Vegetative Maintenance

Vegetative maintenance is the pruning and maintenance of trees, bushes, and other vegetation that could increases threats to power lines during storms, or could act as fuels during wildfires. This could be applied in limited areas that have a significant vulnerability to these hazards, such as within utility easements or along the urban-wildland interface.

Vegetative Planting and Treatment/ Fire-resistant landscaping

Vegetative planting and treatments can help to capture and filter runoff or reduce wildfire risk depending on the types of plants used. Perennial vegetation includes grass, trees, and shrubs that cover the soil, reduce water pollution, slow the rate of runoff, increase filtration, and prevent erosion. This type of land treatment includes maintaining trees, shrubberies, and the vegetative cover; terracing (i.e., a raised bank of earth with vertical sloping sides and a flat top to reduce surface runoff); stabilizing slopes; grass filter strips; contour plowing; and strip farming (i.e., the growing of crops in rows along a contour). Other potential options include vegetated swales, infiltration ditches, and permeable paving blocks.

Landscaping also make a difference in the vulnerability of a property to wildfire.

Warning Systems

Warning systems are comprised of two components: monitoring of local conditions and the broadcasting of alerts. An example of monitoring is a system of stream gauges that provide real-time data.

The National Weather Service uses broadcasts via NOAA Weather Radio to alert communities of meteorological events such as floods and tornadoes. Reverse 911

systems and the media (e.g., television, radio) also can be used to alert residents to hazardous situations.

Zoning

Zoning is by far the most common land use control technique used by local governments. While a useful tool for regulating and restricting undesirable land uses, zoning has a somewhat more limited benefit when it comes to mitigation. Zoning is most effective on new development rather than existing development, which does little to address the pre-existing development in hazardous areas. Communities with a large amount of undeveloped land will benefit much more than older, more established communities.

A community might create an overlay zone for high-hazard districts that establishes mitigation requirements for development in those districts. Overlays are also useful for periods of reconstruction. A recovery overlay zone would include temporary planning regulations that might strictly limit reconstruction in the hazard area or could require any new development to include hazard mitigation techniques. The overlay zone would remain transparent until it was triggered by a disaster event.

Even for new development, the issuance of variances, special use permits, rezoning, and the failure to enforce existing codes, however, will weaken zoning's ability to prevent certain types of building practices.

III. Hazard-Specific Activities

The following is a list of potential mitigation activities that are hazard-specific.

Flood

Flood mitigation measures can be classified as structural or non-structural. In simple terms, structural mitigation attempts to eliminate the possibility of flooding at a particular location. Non-structural mitigation removes the potentially affected people or property from the potentially flooded area. The following is a description of potential flood mitigation measures.

Floodplain Management Ordinances

Floodplain management addresses the hazard risk of communities partially or entirely located in a floodplain. Floodplain management ordinances should restrict

development that would increase flood heights and ensure that construction materials and methods used will minimize future flood damage.

Floodplain management ordinances are weakened by development pressures, a lack of suitable sites outside of the floodplain, community desires to be near the water, inability to effectively monitor floodplain management activities, or by land use planning policies that are encouraging development into floodplain areas.

Acquisition

Acquisition involves the purchasing of property in a hazardous area, which is subsequently cleared and permanently held as open space. Acquisition permanently moves people and property out of harm's way, increases floodplain capacities, recreation areas and open space, and can help to preserve wetlands, forests, estuaries and other natural habitats. Participation in federally-funded grant programs requires voluntary participation by the owner.

Acquisition programs can be expensive to undertake, and the property will no longer accrue taxes for the community and must be maintained, but it is by far the most effective and permanent mitigation technique. Acquisition is most effective when targeting repetitive loss structures, extremely vulnerable structures, or other high-hazard areas.

Basement Backflow Prevention

Check valves, sump pumps, and backflow prevention devices in homes and buildings can be used to prevent flooding in basements from sewer backflows. This option can be done only if the infrastructure allows it.

Channel Modification

Changes to the stream bed, such as dredging or lining the channel, can improve the flow and capacity of the stream. By improving the ability of the stream to move surplus water, the flood risk can be reduced. Channelization projects are designed to move water quickly away from developed areas.

Dry Floodproofing

Dry floodproofing involves making all areas below the flood protection level watertight by strengthening walls, sealing openings, using waterproof compounds, or applying plastic sheeting on the walls. This method is not recommended for

residential structures, but may work well for new construction, retrofitting, or repairing a non-residential structure. Due to pressure exerted on walls and floors by floodwater, dry floodproofing is effective on depths less than 2 to 3 feet. Floodproofing of basements is not recommended.

Elevation

Elevation is the raising of a structure above the Base Flood Elevation. Elevation is often the best alternative for structures that must be built or remain in flood-prone areas, and is less costly than acquisition or relocation. However, elevating a structure can increase its vulnerability to high winds and earthquakes. Some building types are either unsuitable or cost-prohibitive to elevate.

Open Space Preservation

Local government can purchase land to prevent development from occurring in hazard-prone areas. Land can be bought through fee simple purchase or conservation easements could be sought. The land can be used as community open space or for recreational purposes, potentially meeting other community goals.

Relocation

Relocation involves the moving of a building or facility to a less hazardous area, on either the same parcel or another parcel. This measure also moves people and property out of harm's way, and is a very effective measure overall. Some building types are either unsuitable or cost-prohibitive to relocate.

Reservoirs

Reservoirs can be used to store water for various purposes including municipal water sources, recreational uses, and flood control. Water can be stored and released at a controlled rate so as not to overwhelm the downstream channel.

Riparian Buffers

Riparian buffers prevent development within a certain distance from a stream or river. The buffer typically retains its natural vegetation that often can retain greater amounts of water than bare soil and thus help to mitigate flood level. The plant roots hold soil in place and slow movement of floodwaters, lessening erosion and sedimentation, while increasing groundwater infiltration. This increased groundwater

infiltration may also improve water quality by reducing the amount of sediment and pollutants flowing into the stream.

Sandbagging

"Sandbags can be used to fill gaps in a permanent protection system, to raise an existing levee or to build a complete emergency levee. Sandbags alone, when filled and stacked properly, can hold back flood water, but they are most effective when used with polyethylene (plastic) sheeting."[2]

Shoreline / Riverine Setbacks

Setbacks establish a minimum distance between an existing shoreline or stream/river and the buildable portion of a lot. By moving the building away from a potential hazard, the risk to the building is reduced. Setbacks also may be used to move development away from steep slopes that are at risk for failure (e.g., landslide).

Stormwater Management / Storm Drainage Systems / Retention and Detention Facilities

New development that increases the amount of impervious surfaces affects the land's ability to absorb the water and can intensify the volume of peak flow runoff. Without efficient stormwater management, runoff could cause flooding, erosion, and water quality problems. Stormwater management plans should incorporate both structural and nonstructural measures in order to be most effective.

Mitigation efforts include the installation, re-routing, or increasing the capacity of storm drainage systems. Examples include the separation of storm and sanitary sewers or drainage easements. Other structural measures include retention and detention facilities that minimize the increase of runoff due to impervious surfaces and new development. Retention facilities allow stormwater to seep into the groundwater. Detention systems accumulate water during peak runoff periods that will be released at off-peak times. Nonstructural measures include establishing impervious surface limit policies and maintenance programs for existing drainage systems.

[2] *Using Sandbags for Flood Protection.* Retrieved from http://www.louisianafloods.org/Mitigation/sandbagsmain3.html on December 20, 2004.

Stream/Channel Maintenance

Waterways should be cleared of debris to allow for the free flow of water during a flood event. If streams or rivers are clogged with debris, damming could occur As a result, areas upstream and adjacent to the unintended dam can receive unanticipated higher flood levels. In addition, downstream areas may be vulnerable to higher flooding if and when the dam breaks.

Structural Flood Control Measures

Water can be channeled away from people and property with structural control measures such as levees, dams, or floodwalls. These measures also may increase drainage and absorption capacities. These structural control measures also may increase Base Flood Elevations and could create a false sense of security.

Wet Floodproofing

The opposite of dry floodproofing, wet floodproofing lets the floodwater actually enter a structure. This technique is effective on deeper flood depths, as it does not have the same potential to build up exterior pressure. Again, this method is not recommended for residential structures and may not be used for basements under new construction, substantial improvements, or substantially damaged structures.

Wetland Preservation and Restoration

Wetlands can store floodwaters and decrease overall flow downstream, thereby reducing the flood risk. Wetlands also act as filters for pollutants, therefore, increasing water quality. Its usefulness as a mitigation technique may decrease with the size of the flood.

Wind

Proper engineering and design of a structure can increase a structure's ability to withstand the lateral and uplift forces of wind. Building techniques that provide a continuous load path from the roof of the structure to the foundation are generally recommended.

Community Shelters/Safe Rooms

Community shelters and concrete safe rooms can offer protection and reduce the risk to life. Locations for these shelters or safe rooms are usually in concrete buildings

such as shopping malls or schools. Communities lacking basements and other protection nearby should consider developing tornado shelters.

Windproofing

Windproofing is the modification of the design and construction of a building to resist damages from wind events, and can help to protect the building's occupants from broken glass and debris. Windproofing involves the consideration of aerodynamics, materials, and the use of external features such as storm shutters. These modifications could be integrated into the design and construction of a new structure or applied to reinforce an existing structure.

Manufactured homes, which tend to be vulnerable to the effects of extreme wind events, can be protected by anchoring the structures to their foundations. Mobile homes could be tied down to their pads in order to prevent them from being destroyed. Public facilities, critical infrastructure, and public infrastructure (such as signage and traffic signals) should all be windproofed in vulnerable areas. However, windproofing is not a viable mitigation technique to protect against tornadoes.

Wind Shutters

Wind or hurricane shutters can reduce the damages from high winds by preventing windows from breaking allowing wind and rain to enter a structure. Shutters come in various materials and can be purchased or built from scratch.

Wildfire

Fuel Breaks

Fuel breaks are used to prevent the spread of a wildfire. Fuel breaks are areas where vegetation and other fuels have been cleared. Roads and driveways can act as fuel breaks.